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ORDOVICIAN BASALTS AND QUARTZ DIABASES IN LEBANON COUNTY, PENNSYLVANIA¹

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As no Paleozoic volcanic rocks have hitherto been discovered in Pennsylvania, the occurrence of an Ordovician basalt flow in Lebanon County is of interest, especially in view of the fact that deep seated intrusives occur in the Octoraro schists of similar age to the southeast.²

The basalts and quartz diabases described below occur in the Lebanon quadrangle, just south of the Swatara Creek, between Jonestown and Lebanon (see Fig. 1). The area is underlain by a thick series of Martinsburg shales, whose outcrop has been considerably extended in width by folding and faulting. Intrusive in it are sills and dikes of quartz diabase, to the northwest of which lie the interbedded basalt flows.

Martinsburg Formation. The Martinsburg formation consists of a thick series of gray, greenish, and reddish shales, with interbedded sandstones, and thin beds of dolomite,—the last notably in the vicinity of the Swatara. A white sandstone is exposed on the Bunker Hills. Slaty cleavage has been developed in the shales. The formation has been overturned, dipping steeply toward the southeast throughout this area.

In the vicinity of the intrusive diabases, the shales have been metamorphosed to dense dark grayish, greenish, or reddish rocks containing veins of epidote or vesuvianite. Such rocks are well exposed just south of the Swatara, 2 miles southeast of Jonestown, and one half mile east of Bunker Hill Station in a cut on the Jonestown-Lebanon road. Under the microscope the rocks are seen to be aggregates of orthoclase, tremolite, epidote, vesuvianite, chlorite, quartz, and rounded zircons.

¹ The district was visited during the latter part of August, 1920. The writer is indebted to Mr. Frank J. Keeley for the privilege of examining his sections of other Pennsylvania diabases, and to Dr. Edgar T. Wherry for a critical examination of this paper.

² Basic breccia (ouachitite) and dikes of nepheline syenite, leucite tinquaite, and camptonite of Post-ordovician age occur in the northwestern corner of the Franklin Furnace quadrangle, New Jersey. U. S. G. S. Franklin Furnace Folio, 162, 1908.

Quartz Diabase. The quartz diabases form minor wooded ridges, rising above the country occupied by the softer shales in which they occur as sills and dikes. The exposures consist chiefly of enormous boulders, many of which have travelled slowly down the hillsides, and have been collected from the fields by the farmers to form stone



Fig. 1.—Ordovician Basalts and Quartz Diabases of Lebanon County, Pennsylvania.

fences. When the need for road metal arose, these rocks, locally known as "iron-stone," have been crushed.

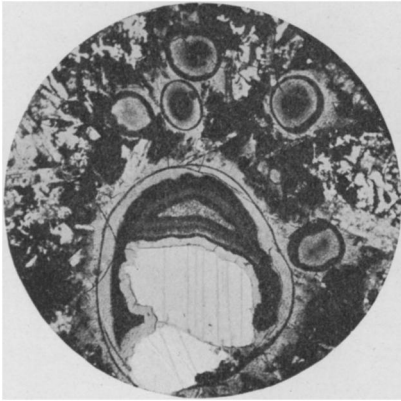
The quartz diabase (Fig. 2.) is typically a fine-grained, dark greenish black or mottled black and gray rock, which may become



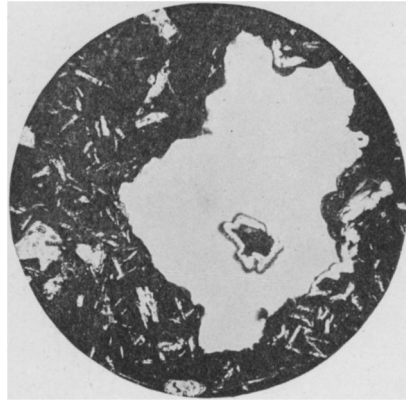
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Fig. 2.—Quartz diabase, three miles northwest of Lebanon. (Slide 1, $\times 15$). Structure ophitic; latbs of labradorite, euhedral augite, with interstitial graphic intergrowths of quartz and orthoclase.

Fig. 3.—Edge of fragment of basalt in glass, separated by a vein of calcite. One mile southwest of Jonestown. (Slide 19, $\times 15$).

Fig. 4.—Basalt glass, amygdaloidal; one mile southwest of Jonestown. (Slide 20, $\times 25$). Shows perlitic structure in the glass, and a calcite amygdule (white).

Fig. 5.—Amygdule of quartz in basalt; one mile southeast of Jonestown. (Slide 27, $\times 25$).

All in ordinary light.

quite fine-grained at the contacts. Three miles northwest of Lebanon, the quartz diabase is porphyritic, with black augite phenocrysts up to 1 cm. in length, in labradorite.

The texture is diabasic or ophitic. The labradorite is quite zoisitized, and the associated augite is more or less altered to chlorite, all stages of the alteration from incipient changes along cleavage cracks to complete chloritized individuals being shown in thin section. Graphic intergrowths of quartz and orthoclase form interstitial aggregates. Magnetite and pyrite are the principal accessory minerals, the latter being recognizable in most hand specimens.

Basalt. The basalts are exposed along the Swatara Creek, on the north slope of Bunker Hill, along the railroad cut one half mile north of Bunker Hill Station, and in the road cut one half mile east of Bunker Hill Station.

The rock is chiefly a brecciated or tuffaceous amygdaloidal basaltic glass, indicating that the flow occurred under water on the floor of the Ordovician sea. The brecciated character is well shown on weathering, which also causes the rock to assume a vesicular appearance due to the weathering out of the calcite amygdules.

Freshly broken specimens show angular fragments of dense black glass in an aggregate of greenish glass and calcite amygdules. On weathering the rock becomes dark yellow. The most typical basalt occurs two miles southeast of Jonestown, where it forms a dense crystalline rock, with amygdules of calcite, or more rarely, of quartz.

Under the microscope, the basalt breccia (Figs. 3-5) is seen to be composed of greenish glass ($n < 1.60$) showing perlitic structure, which exhibits strain effects or incipient crystallization under crossed nicols. The glass is filled with inclusions, and larger fragments of crystalline basalt, consisting of aggregates of plagioclase laths and augite in a dark glassy groundmass, similar to the crystalline basalt, two miles southeast of Jonestown.